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Medical Bacteriology- Lecture 3

Host Immune Defenses against Pathogenic Bacteria

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Host Defenses

Healthy human can defend itself against pathogens at different stages in the infectious disease process. The host defenses may be prevent entirely of infection. Or, if infection does occur, the defenses may stop the process before disease is apparent.

Host defense mechanisms are divided into two groups:

1. Innate Defenses. Also known as ("natural" or "constitutive" resistance)

2. Adaptive Defenses. Also known as (acquired or inducible immunity)

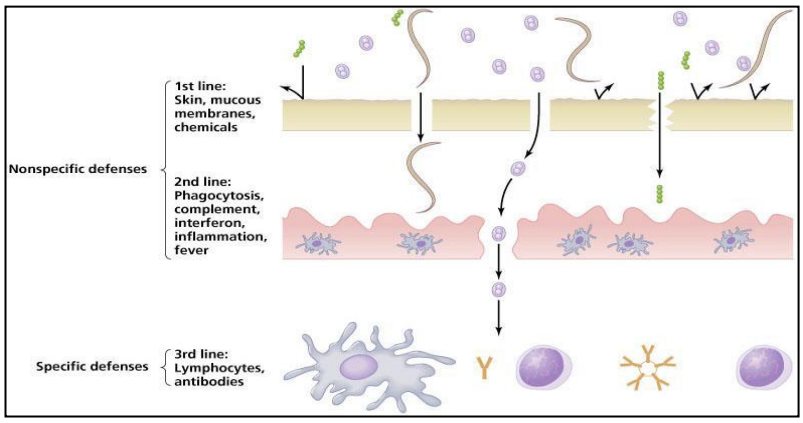
Adaptive Immunity is divided into two types

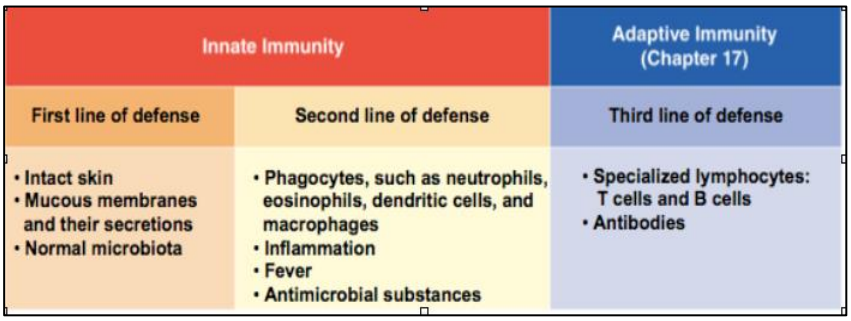
1- Active immunity, the host produces its own antibodies and/or lymphocytes. Active immunity can persist a long time in the host.

2- Passive immunity the host receives antibodies and/or immuno-reactive lymphocytes originally produced in another animal. Passive immunity is typically short-lived.

Innate defense Vs. Adaptive defense

Innate Immunity	Adaptive Immunity
Common, inherent Natural to all healthy human. That meaning they are continually ready to respond and do not require a period of time for induction,	They are not immediately ready to come into play until after the host is exposed to the pathogen. Must be induced by host exposure to a pathogen (as during an infection).
Generally lacks specificity	Highly specific for a particular pathogen
Generally lacks memory	Possesses memory i.e. the onset of the response is fast successive exposures to the pathogen
First and second line of host defenses	Third line of host defense
Includes: anatomical and structural barrier - Inflammation – Complement- fever, phagocytosis - presence of normal flora ,	involve the immunological responses to a pathogen causing an infection. Antimicrobial chemicals, but no physical barriers
Cellular components: Mast cells, monocytes/macrophages, Natural Killer cells (NK), polymorphonuclear leukocytes (PMNL), cells are primarily involved	Antigen-presenting cells, T lymphocytes and B lymphocytes are the major cellular components





Host Defense against Bacterial Infection

- **First Line of host defense**

A- External Barriers:

1- Physical Barriers:

Skin

The **intact skin-** rarely penetrated by bacteria. If the integrity of the epidermis is broken, invasive bacteria may enter.

The **normal flora** of the skin, which metabolize substances secreted onto the skin, produce end products that prevent the colonization of skin by pathogens. **Perspiration** contains **lysozyme** and other **antimicrobial substances**. **Salt-**inhibits growth of pathogen by drawing water from their cells, and Lysozyme-destroys cell wall of bacteria.

Lowers the pH of the skin to a level inhibitory to many bacteria

Mucous membranes

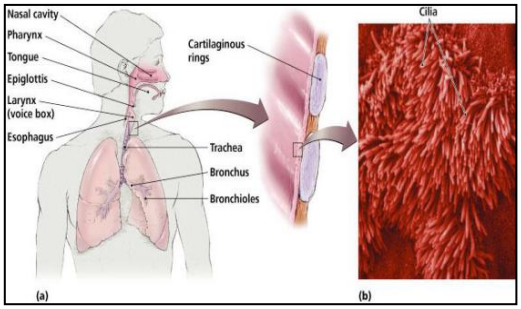
Line all body cavities open to the outside environment. Colonized with **normal flora** that restricted pathogens. The **normal flora** established on mucous membranes may antagonize pathogens. Mucus contains a number of types of **anti-microbial** compounds, including **lysozyme** and **secretory antibodies (IgA).**

Respiratory tract

Hairs of the nares (nasal membranes) entrap bacteria which are inhaled. Those which pass may stick to mucosal surfaces of trachea or be swept upward by the **ciliated epithelium** of the lower respiratory tract.

Coughing and **sneezing** also eliminate bacteria.

The lower respiratory tract (lung) is well protected by **mucus**, **lysozyme, secretory antibody,** and **phagocytic cells.**



Mouth, stomach and intestinal tract.

Microorganisms entering by the oral route, more than any other, have to compete with the **normal flora** of the mouth and intestine.

Lysozyme and other antibacterial enzyme (saliva)

Most organisms that are destroyed by **acid** and various secretions of the stomach.

Alkaline pH of the lower intestine can prevent other organisms.

The **flushing action of the intestine** ultimately flushes out organisms which have not succeeded in colonization.

Bile salts and **lysozyme** are present, which kill or inhibit many types of bacteria.

Urogenital Tract.

The **flushing mechanisms** and **acidity** of urine maintain the bladder and most of the urethra free of microbes.

The vaginal epithelium of the female maintains a high population of *Lactobacillus acidophilus* whose acidic end products of metabolism **(lactic acid**) prevent colonization by most other types of microorganisms including potentially-pathogenic yeast (*Candida albicans*).

Eyes (Conjunctiva).

Blinking mechanically removes microbes

Tears washes the surface of the eye, and the tears contain large amounts of **lysozyme.**

2- Mechanical Barriers:

Chemical Barriers:

Many body organs secrete chemicals with antimicrobial properties

(Stomach acid - Vaginal pH - Skin pH – Lysozyme- fatty acids-sweat)

Microbial flora:

The normal flora **antagonize** colonization of body surfaces by non-indigenous bacteria. Normal microbiota help to protect the body by **competing** with potential pathogens.

Secrete antimicrobial substances that limit pathogen growth.

Consumption of nutrients makes them unavailable to pathogens.

Create an environment unfavorable for pathogens by changing pH.

Helps stimulate the body defense.

Promote overall health by providing **vitamins** to host.

If these **barriers** are **penetrated**, the body contains **cells** that respond rapidly to the presence of the invader. These cells include **macrophages and neutrophils** that engulf foreign organisms and kill them. Bacterial invasion is also challenged by the activation of **complement** in blood and tissues and the **inflammatory process** which has the tendency to focus both the **innate and adaptive immune defenses** on the site of invasion.

• Second Line of host defense

B- Internal barriers:

- **Phagocytic cells:** Monocytes, Macrophages, Polymorphonuclear leukocytes (PMNs)
- **Lysozyme** (mucus, all body tissues and secretions).
- **Bactericidal substances** (internal tissues).
- **Iron Content.**
- **Chemotaxis**
- **Complement system:** role in inflammation, phagocytosis and bacterial killing. Also play a role in adaptive immunity.

• Third line of host defense

Antigens: chemical substances of high molecular weight, that stimulate the immune response. Bacteria are composed of various macromolecular components that are antigens in their host and bacterial antigens interact with the host immunological system in a variety of ways.

Lymphocytes:

B- cells; Immunoglobulins(Antibodies):IgG, IgM, IgA, IgE, IgD (Humoral immunity)

T- cells; (Cellular Immunity)

Inflammation (Non-specific response)

Inflammation is necessary for host defenses functions, because it focuses all circulating antimicrobial factors on the site of infection (include; phagocytes, lymphocytes, antibodies, complement and other antimicrobial components of plasma)

Inflammation can be induced by certain **immunological reactions**, **tissue damage**, or the **entry of an injurious agent** (microbial or non-microbial).

Certain bacterial cells and/or their products (e.g. structural components or toxins) can induce an inflammatory response

the **characteristic symptoms (signs of inflammation)** are;

Redness (due to increased blood flow to the area of injury)

Swelling (due to increased extravascular fluid and phagocytes to the damaged area)

Heat (due to the increased blood flow and the action of pyrogens (fever-inducing agents).

Pain (caused by local tissue destruction and irritation of sensory nerve receptors)

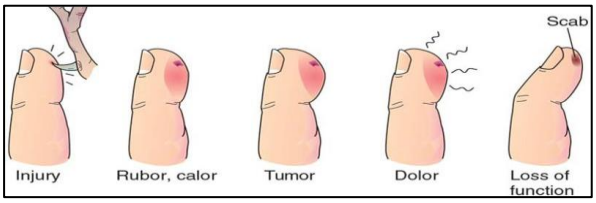
If a whole organ or tissue is involved, **loss of function** may occur (the fifth sing which is sometimes present).

Inflammation functions:

- To destroy and remove pathogens and debris.
- To confine pathogens; prevent spread of infection.
- To repair or replace damaged tissue (sets stage for wound repair).

Inflammation increases blood supply and temperature in the inflamed tissues, which have maximal metabolic activity of the leukocytes, and lowers the pH slightly, which tends to inhibit the multiplication of many microorganisms.

4 Inflammation signs: redness, heat, swelling & pain



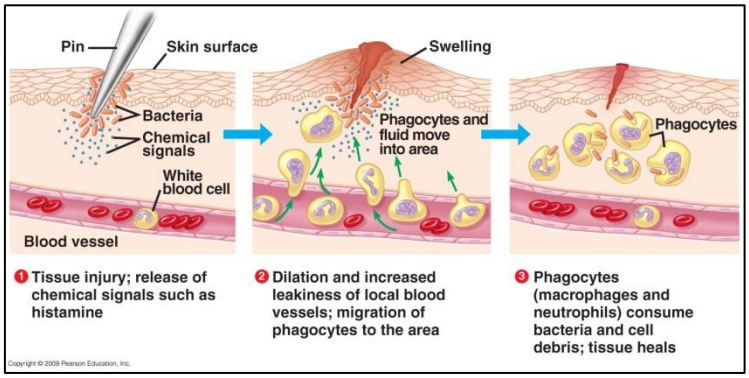
Inflammatory Response steps:

1) Skin/cells are damaged.

2) Mast cells release **chemical messengers (**Histamine); histamine causes blood vessels to expand. This causes redness & increased heat in the affected region.

As a side effect, histamine causes itchiness. vessel walls more permeable or leaky

3) From the openings of blood vessels, phagocytes, Neutrophils & macrophages remove microbes or damaged tissue by phagocytosis (eating) and pus is formed.
Fever is triggered to kill pathogen.
Clotting factors, and platelets come out (healing). This causes swelling in the affected tissue.



Some Antimicrobial Substances Present in Body Fluids and Organized Tissues

Substance	Common Sources	Activity
*Lysozyme	saliva, sweat, tears	Bacterial cell lysis
*Complement	Serum	lysis of bacteria, shares in inflammation
*Lactoferrin & transferrin	Body secretions, serum	Inhibit bacteria by chelate iron
*Peroxidase	tissues, neutrophils	Act with peroxide to cause lethal oxidations of cells
*Fibronectin	Serum & mucosal surfaces	Clearance of bacteria (opsonization)
*Interleukins	Macrophages, lymphocytes	Cause fever; promote activation of immune system

Review Questions

1- Compare between Innate and adaptive immunity?

2- What do you know about external barriers?

3- If the Pathogenic Bacteria Pass first lines of host defenses, what will be faced after that?

4- Give two examples of the phagocytic cells?

5- What do you know about inflammation, signs, functions, steps?

6- You studied some of the antimicrobial substances of host body fluids and tissues, explain them?